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Techniques for Evaluation of E-beam Evaporative Processes

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ABSTRACT

Efforts to evaluate and characterize electron beam evaporation processes at LLNL have produced a number of techniques and capabilities which have proven useful in advancing our process understanding. One of these diagnostic tools, high dynamic range video imaging of the molten pool surface, has provided insight regarding process responses at the melt pool liquid-vapor interface.

A water cooled video camera provides continuous high resolution imaging of the pool surface from a low-angle position within 20 cm. of the liquid-vapor interface. From this vantage point, the e-beam footprint is clearly defined and melt pool free surface shape can be observed. Effects of changes in e-beam footprint, power distribution and sweep frequency on pool surface shape and stability of vaporization are immediately shown.

Other electron beam melting and vaporization events have been observed and recorded. These include: formation of the pool and dissipation of "rafts" on the pool surface during start-up, behavior of feed material as it enters the pool, effects of feed configuration changes on the mixing of feed entering the pool volume and behaviors of co-evaporated materials of different vapor pressures at the feed/pool boundary. When used in conjunction with laser vapor monitoring capabilities (presented at the 1994 Electron Beam Melting and Refining Conference, Reno NV), correlations between pool surface phenomena and vaporizer performance have been identified.

This video capability was used in verifying the titanium evaporation model results presented at this conference by confirming the calculated melt pool surface deformations caused by vapor pressure of the departing evaporant at the liquid-vapor interface.

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